5 Conclusions

This study demonstrates that secondary waves characteristic of those generated by navigation traffic in the UMR system are capable of causing significant direct damage to submersed macrophytes. The results indicate that the level of damage will depend on interactions between the ambient current velocity, wave height, exposure time, plant morphology, and plant size. The conclusions are as follows:

a. Under low ambient currents (<0.25 m/sec), damage significantly increases with wave heights greater than 0.1 m.

b. Under ambient currents of 0.25 m/sec or greater, damage appears to be more related to exposure time than to wave height.

c. Eurasian watermilfoil was damaged more than vallisneria; higher damage to milfoil probably resulted from the tendency of its shoots to become entangled by waves.

d. Canopy-forming plant species with leaves and branches projecting from the shoots (e.g., milfoils and pondweeds) will probably be damaged by waves more than species with individual, ribbon-like leaves arising from basal rosettes (e.g., vallisneria).

e. Susceptibility to direct damage to canopy-forming species will increase during the growing season as more biomass is produced and distributed at the water surface.

f. Plants growing under field conditions in the UMR may be able to withstand higher tensile loadings than greenhouse-cultured plants used in this study and, therefore, be less susceptible to direct damage from secondary waves.

Direct damage from navigation-generated secondary waves may be partially responsible for the paucity of submersed macrophytes at intermediate depths along the main channel border area of the UMR system. At these intermediate

depths, plant growth is probably limited by both high light attenuation through the water and repeated exposures to secondary waves generated by navigation traffic. These two factors may be working collectively to restrict the growth of species such as vallisneria and milfoil; the former being morphologically adapted (i.e., ribbon-like leaves) to survive repeated wave exposures but fairly intolerant of low light (i.e., basal meristem), and the latter being morphologically adapted (i.e., canopy forming) to overcome low light but fairly intolerant of wave exposures (i.e., susceptibility to entanglement). Other sources of waves (e.g., wind and recreational boating) similar to those tested in this study may generate similar levels of direct damage to submersed aquatic plants. Whereas direct damage from navigation-generated secondary waves is, in most cases, limited to the main channel border area where submersed plant communities are not common, direct damage from other sources of waves may be more widespread.